TORSIONAL VIBRATION DAMPING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent claims priority of German patent application 102 58 998.4, which application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] This invention relates generally to a torsional vibration damping apparatus, especially a web damper, for mounting on a crankshaft of a piston engine, especially an internal combustion engine. The invention also relates to a crankshaft and a piston engine having a torsional vibration damping apparatus.

[0003] Traditional torsional vibration damping apparatuses for crankshafts, especially web dampers, often comprise multiple cast parts, which must be expensively finish-machined.

OBJECTS OF THE INVENTION

[0004] The object of the present invention is therefore to provide a torsional vibration damping apparatus, especially a web damper of the type described at the outset, that can be inexpensively produced.

[0005] This objective is achieved for a torsional vibration damping apparatus, especially a web damper for mounting on a crankshaft of a piston engine, especially an internal combustion engine, in that the torsional vibration damping apparatus comprises multiple sheet metal parts. The sheet metal parts provide the advantage that they are easily and economically produced. The sheet metal parts can be produced, for example, from drawn sheet metal. Individual areas of the sheet metal parts, such as boreholes or openings can be punched out. It is also possible to machine individual areas of the sheet metal parts using metal cutting tools.

BRIEF SUMMARY OF THE INVENTION

[0006] A preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the torsional vibration damping apparatus comprises a housing that is fastened to the crankshaft and to which at least one rotary mass is coupled, spring elements being disposed between said housing and said mass. This supplies the advantage that the torsional vibration damping apparatus can be pre-assembled. The pre-assembled torsional vibration damping apparatus can then be fastened to the crankshaft of a piston engine in one assembly step.

[0007] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the housing comprises an essentially pan-shaped sheet metal part with a base that has an essentially rectangular opening that is open on one side. The opening is used to join the torsional vibration damping apparatus in an interlocking manner to an area of the crankshaft of the piston engine that has a complementary configuration.

[0008] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that an essentially circular-segment-shaped shoulder is formed on the housing in the area of the cutout. The circular-segment-shaped shoulder is used to fasten the torsional vibration damping apparatus to the crankshaft of a piston engine.

[0009] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that at least one through hole is provided in the circular-segment-shaped shoulder. The through hole is used to receive fastening means, such as screws, with which the torsional vibration damping apparatus can be fastened to the crankshaft of a piston engine.

[0010] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the base of the housing has a round rim that is bent 90°. The bent or turned rim outwardly delimits the housing in the radial direction.

[0011] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the housing on the side that faces away from the base can be enclosed by a cover that is formed from a sheet metal part. The outer contour of the cover is preferably adapted to the inner contour of the bent rim of the housing base.

[0012] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the housing base and the housing cover are attached to each other using spacer bolts. The spacer bolts ensure a spaced arrangement of the two housing parts. The housing cover can, however, also be attached to the housing base using a welded joint at, for example, the bend rim of the base.

[0013] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that arranged within the housing is at least one flywheel mass that is formed by at least one sheet metal part. The sheet metal part can be economically produced, for example, by punching.

[0014] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that at least one sliding element is mounted on the flywheel mass on the radially outward side. The sliding element is used to minimize the friction between the flywheel mass and the housing, especially inside at the bent rim of the housing base. For this purpose, the sliding element is preferably made out of plastic.

[0015] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that at least one oblong opening is made in each of the housing

base, the flywheel mass and the housing cover, the openings in the housing base, the flywheel mass and the housing cover being tangentially arranged in such a manner that they are in alignment when the torsional vibration damping apparatus is in the assembled state. The openings are used to hold compression springs, by which the flywheel mass is coupled to the housing.

[0016] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that through holes are provided on the housing base to hold weighting rivets. The weighting rivets are fastened as needed in different sizes and numbers on the housing bases.

[0017] Another preferred exemplary embodiment of the torsional vibration damping apparatus is characterized in that the torsional vibration damping apparatus is essentially configured in the shape of a horseshoe. This supplies the advantage that the torsional vibration damping apparatus can be integrated in a space-neutral manner in the crank web of a crankshaft. This means that both the housing base and the housing cover are configured in the shape of a horseshoe.

[0018] On a crankshaft for a piston engine, especially for an internal combustion engine, having several webs, the objective indicated above is achieved by a previously described torsional vibration damping apparatus being integrated into at least one web of the crankshaft.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Additional advantages, features and details of the invention emerge in the following description in which:

Figure 1 is a perspective, partial cross-sectional view of a torsional vibration damper mounted on a crankshaft;

Figure 2 is another perspective illustration of the mounted torsional vibration damper from Figure 1;

Figure 3 is a perspective illustration of the housing base of the torsional vibration damping apparatus in isolation;

Figure 4 is another perspective view of the housing base from Figure 3 in separated form;

Figure 5 is an exploded view of the torsional vibration damping apparatus shown in Figures 1 and 2;

Figure 6 is an exploded view of the flywheel mass of the torsional vibration damping apparatus illustrated in Figure 5;

Figure 7 is a perspective illustration as a line drawing of the torsional vibration damping apparatus;

Figure 8 illustrates the torsional vibration damper from Figure 7 in horizontal projection;

Figure 9 is a view taken generally along line IX-IX in Figure 8;

Figure 10 is a view taken generally along line X-X in Figure 8; and,

Figure 11 is a view taken generally along line XI-XI in Figure 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] Torsional vibration damping apparatuses, which can also be called vibration dampers, are used among other things to suppress natural torsion frequencies from crankshafts. In many cases, such a natural frequency is present in the range of approximately 300 to 450 Hz. It is stimulated in particular by the irregularity that results from the compression and expansion occurring in the pistons. A vibration in the torsional resonance can lead to breakage of the crankshaft, which is why torsional vibration dampers or torsional vibration cushions are used. The torsional vibration damping apparatus is also called a rotary vibration damping apparatus.

[0021] A torsional vibration damping apparatus having a spring coupling is comprised in principle of a rotary mass having a defined moment of inertia that is joined to the crankshaft via spring elements. The natural frequency of the damper, which must be harmonized with the natural frequency of the crankshaft, is produced by the torsion resistance of the spring elements and the moment of inertia of the rotary mass. The vibration properties of the crankshaft are altered by the torsional vibration damping apparatus. The system gains an additional degree of freedom; at damping to zero, the original point of resonance disappears completely, and therefore two new resonance levels occur. At a very high level of damping, no effect is produced, the damper is almost rigidly coupled, and approximately the base resonance of the crankshaft appears. When the damping is correctly designed, neither the new resonance levels nor the original ones emerge disruptively.

[0022] In Figures 1 and 2, a vibration damper **1** is shown that is fastened with screws **2** and **3** to crankshaft **4**. Vibration damper **1** is located on the first crank web, is fastened to the crankshaft using two radial screws **2** and two axial screws **3** and then is installed together with it in the engine block. Vibration damper **1** simultaneously replaces one of the counterweights of crankshaft **4**.

[0023] Shown in isolation in Figures 3 and 4 is a housing base **8** of the torsional vibration damping apparatus **1** that is described in Figures 1 and 2. Housing base **8** has essentially the form of a circular disk whose rim **9** is bent into an angle of approximately 90°. Two flat faces **10** and **11**, in which through holes **13** and **14** are placed, are formed on bent rim **9** of housing base **8**. Through holes **13** and **14** are used to pass through screws **2**, which are illustrated in Figures 1 and 2 and used to fasten torsional vibration damping apparatus **1** to crankshaft **4**.

[0024] Between two flat faces **10** and **11**, an essentially rectangular opening **16** is arranged in housing base **8**. Opening **16** is open on one side and forms an interlocking area, which facilitates an interlocking joint between housing base **8** and the crankshaft (not shown in Figures 3 and 4).

[0025] In the central area of housing base **8**, rectangular opening **16** is delimited by a circular-segment-shaped shoulder **18** in which two through holes **19** and **20** are provided. Through holes **19** and **20** are used to pass through screws **3**, which are depicted in Figures 1 and 2 and used in turn to fasten the torsional vibration damping apparatus to the crankshaft.

[0026] Moreover, through holes **22** and **23** for holding weighting rivets are provided in housing base **8** radially toward the outside close to bent rim **9**. Arranged radially further inward are mounting holes **24** and **25**. Mounting holes **24** and **25** are used, for example, to hold mounting tools or aids.

[0027] Radially toward the outside, also close to bent rim **9**, five through holes **27** that are used to hold or fasten spacer bolts (not shown) are provided in housing base **8**. Arranged between every two through holes **27** is an oblong window **30**, which is used to hold spring elements (not shown).

[0028] Housing base **8**, which is depicted in Figures 3 and 4, is formed out of drawn sheet metal. Through holes **13, 14, 19, 20, 22, 23, 24, 25** and **27**, as well as window **30** and opening **16**, were punched out of drawn sheet metal. Areas **34** and **35** of housing base **8** are machined out with metal cutting tools.

[0029] In Figure 5 one sees that housing base **8**, which can also be called a housing pan, can be enclosed by a housing cover **41** that is essentially configured in the shape of a horseshoe. Four windows **43** are provided in housing cover **41** that are configured to be congruent to

windows **30** in housing base **8**. Windows **43** are each arranged between two through holes **45-46**; **46-47**; **47-48** and **48-49**. Through holes **45** to **49** are used, just like through holes **27** in housing base **8**, to hold or fasten spacer bolts **50** to **54**. Spacer bolts **50** to **54** are used to hold housing cover **41** at a defined distance from housing base **8**.

[0030] Weighting rivets **55**, which can be mounted in housing base **8** as needed in through holes **22** and **23**, are also depicted in Figure 5.

[0031] Spacer bolts **50** to **54** create a housing space between housing base **8** and housing cover **41** radially within bent rim **9** of housing base **8** for a flywheel mass **56**, which is also configured in the shape of a horseshoe. Flywheel mass **56**, like housing cover **41**, is a punched out sheet metal part. Provided at the open end of flywheel mass **56** are indentations **57** and **58** for spacer bolts **50** and **54**. Indentations **57** and **58** are sized so that in the assembled state it is possible to turn the torsional vibration damping apparatus within the housing, which is formed from housing base **8** and housing cover **41**, and specifically in spite of the presence of spacer bolts **50** and **54**. Moreover, oblong holes **59**, **60** and **61**, through which spacer bolts **51**, **52** and **53** project in the assembled state of the torsional vibration damping apparatus, are provided in flywheel mass **56**. Oblong holes **59** to **61** are sized so that, in spite of the presence of spacer bolts **51** to **53**, it is possible to turn flywheel mass **56** within the housing. Flywheel mass **56** can be formed in one part or in several parts. In the present case, flywheel mass **56** comprises multiple parts that are held together by rivets **63**.

[0032] Windows **30**, **43** and **68** in housing base **8**, housing cover **41** and flywheel mass **56** are used to hold compression springs **65**, which are routed through cups **66**. Compression springs **65** are pre-tensioned in the installed state and couple flywheel mass **56** to the housing. Windows **68**, which are provided in flywheel mass **56**, have the same length but a greater width

than windows **43** in housing cover **41** and windows **30** in housing base **8**. The lesser width of windows **43** and **30** prevents compression springs **65** from falling out of the housing through windows **30** and **43**. For this purpose, the width of windows **43** and **30** is smaller than the diameter of compression springs **65**. The width of window **68** in flywheel mass **56** is somewhat larger than the diameter of compression springs **65**.

[0033] In Figure 6 one sees that flywheel mass **56** from Figure 5 is formed from a first sheet metal part **71** and a second sheet metal part **72**. The two sheet metal parts **71** and **72** are held together by rivets **74**, which correspond to rivets **63** in Figure 5. Radially to the outside, a sliding element **75** made of plastic, which essentially has the shape of a circular ring section, is fastened between or on the two sheet metal parts **71** and **72**. Sliding element **75** in the installed state comes to rest against the inside of the bent rim **9** of housing base **8**.

[0034] In Figures 7 to 11, the torsional vibration damping apparatus in the assembled state is illustrated in different views. The frictional damping is produced by a combination of compression spring pre-tensioning and the centrifugal force on the flywheel mass or damper mass. To produce a pre-tensioning force and additional friction, an additional, axial spring element may be provided.

[0035] Thus it is seen that the objects of the invention are efficiently obtained, although modifications to the invention should be readily apparent to those having ordinary skill in the art, and these changes and modifications are intended to be within the scope of the claims.